

Radiative strength function in ^{96}Mo reanalyzed

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The radiative strength functions of ^{96}Mo have been reanalyzed. The enhanced γ strength for $E_\gamma < 3 - 4$ MeV is confirmed.

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INTRODUCTION

The Oslo group has reported unexpected enhancements in the radiative strength functions (RSF) of low energy γ -rays for the $^{44,45}\text{Sc}$, $^{50,51}\text{V}$, $^{56,57}\text{Fe}$ and $^{93-98}\text{Mo}$ nuclei [1, 2, 3, 4]. These results, which have been obtained with the Oslo method [5], have gained broad interest in the nuclear physics community. The ^{96}Mo nucleus has become a benchmark for other experimental groups trying to verify or falsify the Oslo results. Unfortunately, ^{96}Mo was not analyzed in an optimal way, and we have therefore decided to reanalyze these data sets.

REANALYZED DATA AND RESULTS

The two data sets were recorded from the $^{96}\text{Mo}(^3\text{He}, ^3\text{He}'\gamma)^{96}\text{Mo}$ and $^{97}\text{Mo}(^3\text{He}, \alpha\gamma)^{96}\text{Mo}$ reactions. In this work we use the same key parameters for the normalizations as previously [4, 6], namely a level density of $\rho(B_n) = 71800 \text{ MeV}^{-1}$ and an average total radiative width of $\langle\Gamma(B_n)\rangle = 150 \text{ meV}$ (from s -wave resonances) at the neutron binding energy B_n . Experimental details and further references are found in Refs. [4, 5, 6].

The new analyzes concern two major points. In the old extraction of RSF, we included the γ -ray energies close or below the strong 778 keV $2^+ \rightarrow 0^+$ ground band transition. This transitional region in the experimental (E_γ, E) matrix is not properly subtracted in the first-generation procedure [7] and is now excluded.

The second point concerns the estimate of the γ -ray multiplicity as function of excitation energy, which is an important quantity both for normalizing the γ spectra with respect to each other and weighting the higher-order generation spectra in the subtraction procedure [7]. In the previous analyses,

we estimated the statistical multiplicity at excitation energy E by introducing a lower γ -ray threshold E_0 and an effective excitation energy $E - E_{\text{entry}}$ giving

$$\langle M_\gamma^{\text{stat}} \rangle = (E - E_{\text{entry}}) / \langle E_\gamma \rangle_{>E_0}, \quad (1)$$

where $\langle E_\gamma \rangle_{>E_0}$ is the average energy of the γ spectrum for $E_\gamma > E_0$. The E_{entry} parameter mimics the excitation energy at which the statistical γ transitions enter the ground band. This treatment is applicable to rare earth nuclei, where the detector system efficiency for the lowest ground state band transitions, typically the $4^+ \rightarrow 2^+$ and the $2^+ \rightarrow 0^+$ transitions, is low. However, for ^{96}Mo the energy of the lowest ground band transitions are detected easily. Therefore, in the present analysis we use the straightforward expression for the total γ -ray multiplicity

$$\langle M_\gamma^{\text{tot}} \rangle = E / \langle E_\gamma \rangle, \quad (2)$$

where we simply divide the excitation energy by the average energy of the γ spectrum.

Both the level density and the radiative strength function will be slightly modified by the new multiplicity expression. Figures 1 and 2 compare the new level densities and radiative strength functions with previous data [4, 6]. We see a very good resemblance between the pick-up reaction and the inelastic scattering reaction. The error bars include statistical errors only. The new level densities are very similar to the previous ones. The same is true for the RSFs, except that the upbend is less pronounced due to the exclusion of the 778 keV transition. The values of the data points can be found at <http://ocl.uio.no/compilation/>.

There have been some misunderstandings concerning the description of the RSF upbend for low γ energies given by [7]

$$f_{\text{upbend}} = \frac{1}{3\pi^2\hbar^2 c^2} \mathcal{A} E_\gamma^{-b}, \quad (3)$$

where \mathcal{A} and b are fit parameters, and E_γ is given in MeV. The formula was chosen in order to fit the low-energy data by only two parameters. We would like to stress that this description

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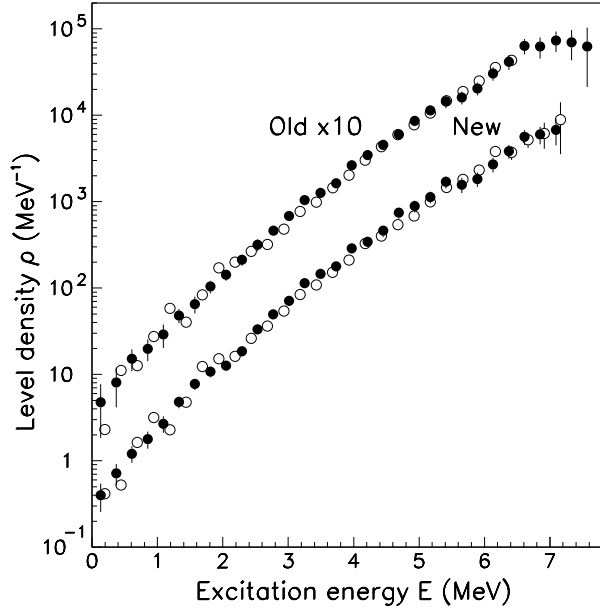


FIG. 1: Experimental level densities from the $(^3\text{He}, \alpha)$ (filled circles) and the $(^3\text{He}, ^3\text{He}')$ (open circles) reaction. The data from the new analysis is compared with previously published data [6].

should not be used for γ energies lower than the experimental data points. In the extreme case when $E_\gamma \rightarrow 0$, it is clear that the description is totally unrealistic as it gives wrong γ multiplicity.

SUMMARY AND CONCLUSIONS

The radiative strength function of ^{96}Mo has been reanalyzed giving a slightly less pronounced enhancement at lower γ -ray energies. The data points at and below the 778 keV $2^+ \rightarrow 0^+$ transition have been omitted. Since extraction of level density is coupled to the radiative strength function, new level densities have also been presented.

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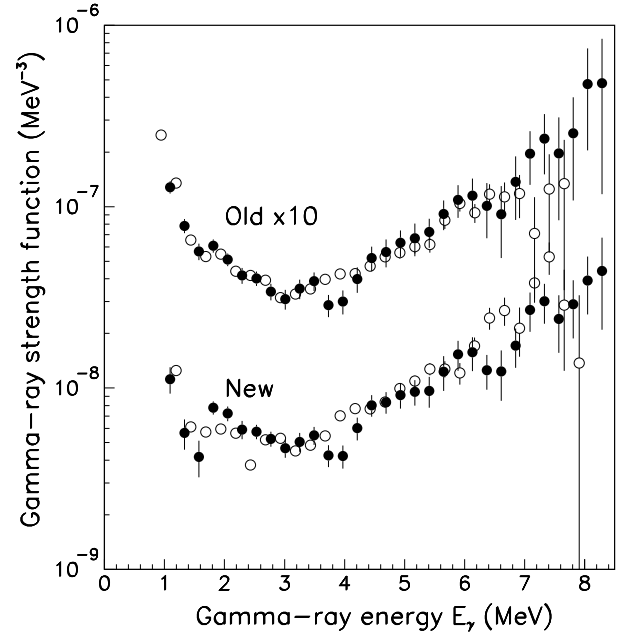


FIG. 2: Experimental radiative strength functions from the $(^3\text{He}, \alpha)$ (filled circles) and the $(^3\text{He}, ^3\text{He}')$ (open circles) reaction. The data from the new analysis is compared with previously published data [7].